

TIBIAL AUGMENTS FOR USE WITH KNEE JOINT PROSTHESES, METHOD
OF IMPLANTING THE TIBIAL AUGMENT,
AND ASSOCIATED TOOLS

1 This application is a continuation-in-part of prior Application Serial No.
2 10/225,774, filed August 22, 2002, which claims the benefit of Provisional
3 Application No. 60/315,148, filed August 27, 2001, both of which are hereby
4 incorporated by reference.

5 The present invention relates generally to a bone augmenting member
6 used to reinforce damaged bone, and more particularly to an augment for the proximal
7 portion of a human tibia, where the augment is intended to be implanted in the
8 proximal portion of the tibia, just slightly below the tibial portion of a knee joint
9 prosthesis. The present invention also relates to the tool used for implanting the tibial
10 augment, and the tools used for making the cavity in the bone to receive the augment.
11 In addition, the invention also relates to a provisional augment used temporarily to
12 ensure that the permanent augment will be seated within the bone correctly, as well as
13 to a holder used for holding, inserting and removing the provisional augment.

14 BACKGROUND OF THE INVENTION

15 Knee replacement surgery methods and knee joint prostheses are known
16 in the art. A typical knee joint prosthesis includes a rounded femoral component that

1 is attached to the distal portion of the femur, and a tibial component, which may be
2 formed of a single piece or from two separate pieces that are joined together, that is
3 attached to the proximal portion of the tibia. The femoral component rides on the
4 exposed surface of the tibial component, replicating natural knee movement as closely
5 as possible. When such knee replacement surgery is performed, an incision is made to
6 expose the knee joint in order to enable removal of both the proximal portion of the
7 tibia and the distal portion of the femur, which creates surfaces upon which the tibial
8 and femoral components of the knee prosthesis can be attached.

9 In certain situations, additional portions of the tibia, other than the
10 relatively narrow proximal portion being removed during knee replacement surgery,
11 may also be damaged by arthritis or other problems. In such situations, a relatively
12 thick proximal portion of the tibia is often removed, and it is replaced with an augment
13 block shaped like the bone that has been removed. However, such previously known
14 methods often result in the removal of an unnecessary amount of healthy bone, along
15 with the damaged bone. Thus, for example, even in cases where the peripheral bone
16 was healthy, and only the internal bone was damaged, prior art methods often removed
17 both the healthy peripheral bone and the damaged internal bone

18 BRIEF SUMMARY OF THE INVENTION

19 The present invention is intended for situations in which the proximal
20 portion of the tibia is defective, and it provides a method and devices that allow for
21 preservation of healthy peripheral bone, while still providing the necessary
22 augmentation to the proximal portion of the tibia. Preservation of the healthy

1 peripheral bone provides for early onset of bony ingrowth into the tibial augment and
2 allows the bone to infiltrate the augment, restoring the bony platform upon which
3 other implants can reside.

4 More specifically, the present invention provides a tibial augment for
5 use with a knee joint prosthesis that is made of an annular member with a proximal
6 surface, a distal surface, an outer anterior surface, an inner anterior surface, an outer
7 posterior surface, an inner posterior surface, an inner lateral surface, an outer lateral
8 surface, an inner medial surface and an outer medial surface. Preferably, the outer
9 lateral surface is curved to define a continuous surface connecting the outer posterior
10 surface and the outer anterior surface; and the outer medial surface is also curved to
11 define a continuous surface connecting the outer posterior surface and the outer
12 anterior surface. In addition, the outer anterior surface is slightly curved and the outer
13 posterior surface is a generally planar surface. The annular member can be made in a
14 variety of different stock sizes, with each size being configured to fit within a cavity
15 formed in a proximal portion of a different sized human tibia.

16 In certain embodiments, the tibial augment of the present invention can
17 include a stepped distal surface, thereby defining a first distal surface and a second
18 distal surface with a transition surface therebetween, where the first distal surface is
19 located at a greater distance from the proximal surface than the second distal surface.
20 The transition surface can be located at different portions of the augment, such as: (1)
21 midway between the outer lateral surface and the outer medial surface; (2) closer to
22 the outer lateral surface than to the outer medial surface; or (3) closer to the outer
23 medial surface than to the outer lateral surface.

1 The present invention also includes a provisional or temporary tibial
2 augment that is used to ensure a proper fit for the permanent augment. The
3 provisional augment is preferably composed of a material that is substantially
4 transparent to allow visualization of the bony contact surfaces that will likely contact
5 the augment. In addition, in the preferred embodiment, the provisional augment
6 preferably includes at least one set of generally lateral/medial extending grooves to
7 facilitate removal of the provisional from the cavity formed in the tibia. The grooves
8 are configured to cooperate with a set of ribs on a tong-like holder used for inserting
9 and removing the provisional from the cavity.

10 The present invention also relates to a pusher for use in implanting the
11 tibial augment, where the pusher includes a handle portion and an augment seating
12 portion. The augment seating portion is connected to one end of the handle portion,
13 and is configured and arranged to seat a particularly sized tibial augment.

14 In addition, the present invention also relates to a system used for
15 creating a cavity in a proximal portion of a human tibia for use prior to implanting a
16 knee joint prosthesis. The system preferably includes a guide with a slot therein and a
17 set of osteotomes that are configured and arranged to be inserted within different
18 portions of the slot on the guide.

19 Additionally, the present invention also relates to a holder for inserting
20 and/or removing a provisional augment to/from a cavity in a bone. The holder
21 preferably includes a body portion, a pair of legs extending from the body portion, a
22 finger connected to each of the legs, and a rib extending outwardly from each of the
23 fingers. Each of the ribs preferably extends in a direction that is generally

1 perpendicular to the longitudinal axis of the body portion, and the ribs are configured
2 and arranged to correspond to grooves on an inner surface of a provisional augment.
3 In a first preferred embodiment of the holder, the pair of legs comprises a pair of
4 flexible legs, such that application of a force upon outer surfaces of the legs allows for
5 the ribs to be disengaged from the grooves on the inner surface of the provisional
6 augment without significantly altering the location of the provision augment. In the
7 second preferred embodiment of the holder, each of the legs is a relatively rigid
8 member, and each of the fingers is attached to one of the legs such that the fingers are
9 movable with respect to the legs, whereby movement of the fingers with respect to the
10 legs allows for the ribs to be disengaged from the grooves on the inner surface of the
11 provisional augment without significantly altering the location of the provision
12 augment. The second embodiment of the holder is also preferably adjustable to permit
13 a single holder to be used with provisional augments of different sizes.

14 The present invention also relates to the methods of using the tools
15 and/or implanting the prosthetic devices discussed above.

16 BRIEF DESCRIPTION OF THE DRAWINGS

17 Preferred embodiments of the present invention are described herein
18 with reference to the drawings wherein:

19 Figure 1 is a perspective view of a preferred embodiment of a tibial
20 augment of the present invention;

21 Figure 2 is a top view of the tibial augment of Figure 1;

1 Figure 3 is an anterior view of the tibial augment of Figure 1, with the
2 posterior view being identical due to symmetry along the major axis;

3 Figure 4 is a lateral view of the augment of Figure 1, with the medial
4 view being a mirror image thereof;

5 Figure 5 is a perspective view of a tibial augment of a different height
6 than that shown in the Figure 1 embodiment;

7 Figures 6A-6C are anterior views of three different stepped versions of
8 the tibial augment of the present invention;

9 Figure 7 is a view of a tibia, shown with the damaged proximal bone
10 surface removed and also including a cavity within which a tibial augment of the
11 present invention will be implanted;

12 Figure 8 is a view of a tibial augment of the present invention, shown
13 implanted in place below a knee joint prosthesis;

14 Figure 9 is a perspective view of a provisional tibial augment of the
15 present invention;

16 Figure 10 is a top view of a holder of the present invention, where the
17 holder is intended for use with the provisional of Figure 9;

18 Figure 11 is a side view of the holder of Figure 10;

19 Figure 12 is a perspective view of a second embodiment of a holder of
20 the present invention;

21 Figure 13 is a front view of the holder of Figure 12;

22 Figure 14 is a perspective view of a pusher of the present invention,
23 which pusher is intended to be used to implant the tibial augment;

1 Figure 15 is a bottom view of the pusher of Figure 14;

2 Figure 16 is a side view of the pusher of Figure 14;

3 Figure 17 is a front view of the pusher of Figure 14, and an enlarged
4 view of the augment seating portion upon which a tibial augment has been seated;

5 Figure 18 is a perspective view of a guide and a curved osteotome of the
6 present invention, which are used for making a cavity for the augment;

7 Figure 19 is a bottom view of the guide of Figure 18;

8 Figure 20 is a side view of the guide of Figure 18;

9 Figure 21 is a side view of the osteotome of Figure 18;

10 Figure 22 is a rear view of the osteotome of Figure 18;

11 Figure 23 is a bottom view of the osteotome of Figure 18;

12 Figure 24 is a bottom view of the osteotome of Figure 25;

13 Figure 25 is a perspective view of the guide of Figure 18, shown with a
14 second osteotome of the present invention;

15 Figure 26 is a perspective view of the guide of Figure 18, shown with a
16 third osteotome of the present invention;

17 Figure 27 is a side view of the osteotome of Figure 26; and

18 Figure 28 is a rear view of the osteotome of Figure 26.

19 DETAILED DESCRIPTION OF THE INVENTION

20 Referring to Figures 1 through 4, a first embodiment of the tibial
21 augment of the present invention is shown. The tibial augment is preferably an
22 annular member 10, and it is preferably made from a tantalum based porous material,

1 such as Trabecular Metal™. Trabecular Metal™ is desirable because it resembles
2 bone and approximates the physical and mechanical properties of bone better than
3 other materials. Use of such a metal enables increased bonding with the adjacent bone
4 by allowing the bone to grow into its highly porous surface. The tibial augment may
5 also be made of other materials, and it is preferably made of a material that facilitates
6 bony ingrowth.

7 The tibial augment 10 is anatomically sized and shaped to fill an existing
8 cavitary defect within the proximal human tibia or a cavity prepared in the proximal
9 portion of a human tibia. In the preferred embodiment, a system of different stock
10 sizes of augments would be available, as discussed more fully below, with different
11 sizes being used for different sized tibias. Further, if desired two augments of
12 different sizes may be stacked upon each other if such stacking is necessary to fill the
13 cavity.

14 As shown in Figures 1 through 4, the tibial augment 10 includes a
15 proximal surface 12, a distal surface 14, an outer anterior surface 16, an inner anterior
16 surface 18, an outer posterior surface 20, an inner posterior surface 22, an inner lateral
17 surface 24, an outer lateral surface 26, an inner medial surface 28 and an outer medial
18 surface 30. Of course, depending on which tibia (right or left) the augment is being
19 implanted into, the surfaces designated as the medial and lateral surfaces will be
20 reversed. However, since the augment is symmetric with respect to its lateral and
21 medial sides, such distinctions are irrelevant, and the terms lateral and medial are
22 being used for convenience of description only.

1 To mimic the portion of the tibia bone that the tibial augment is being
2 implanted into, the outer lateral surface 26 is curved to define a continuous surface
3 that connects the outer posterior surface 20 and the outer anterior surface 16.
4 Likewise, the outer medial surface 30 is curved to define a continuous surface that
5 connects the outer posterior surface 20 and the outer anterior surface 16. The outer
6 anterior surface 16 is slightly curved and the outer posterior surface 20 is a generally
7 planar surface.

8 As best shown in Figures 2 through 4, a majority of the annular member
9 10 is of a substantially uniform thickness, as most readily depicted by the hidden lines
10 of Figures 3 and 4. The major exception to the uniform thickness is a channel 32,
11 shown in Figures 1 and 2, which defines a reduced thickness portion. In the preferred
12 embodiment, the thickness of the majority of the augment is preferably approximately
13 5mm thick, and the thickness of the reduced thickness portion is preferably
14 approximately 3mm at its narrowest point. However, other dimensions are also
15 contemplated as being within the scope of the invention. Although the preferred
16 embodiment includes walls of a substantially uniform thickness, with a reduced
17 thickness portion near channel 32, it is also contemplated that the walls could be
18 tapered, in either direction, between the proximal and distal surfaces.

19 The reduced thickness portion is preferably included to provide a space
20 for the stem of a stemmed tibial base plate of a knee joint prosthesis. One example of
21 such a stemmed tibial base plate is shown in Figure 8, which shows a knee joint
22 prosthesis 100 that includes stemmed tibial base plate 102 with a stem 104 extending
23 through the tibial augment 10. Figure 8 also shows a tibial articulating surface 106

1 and a femoral component 108, which are also parts of the knee joint prosthesis 100.
2 Although the present augment 10 is shown and described for use with a stemmed tibial
3 base plate and includes a channel for accommodating the base plate's stem, it is
4 contemplated that the present invention could also be used with other forms of base
5 plates without stems, and therefore the channel could be omitted. Further, it is also
6 contemplated that the inner surfaces of the tibial augment of the present invention
7 could be modified to accommodate other designs of tibial base plates, such as pegged
8 base plate designs.

9 As shown in Figure 3, both the outer medial surface 30 and the outer
10 lateral surface 26 have a distal taper (i.e. downward slope) of between approximately 8
11 degrees and approximately 30 degrees, with a taper of approximately 19 degrees being
12 preferred. Such tapers replicate the tapers commonly found in corresponding areas of
13 the proximal portions of human tibias. Since the thickness of the annular member 10
14 is generally uniform from its proximal side to its distal side, the inner medial surface
15 28 and the inner lateral surface 24 will also have the same taper as the outer lateral and
16 medial surfaces.

17 Referring now to Figure 4, the outer posterior surface 20 has a distal
18 taper of less than approximately 17 degrees, with a taper of approximately 12 degrees
19 being preferred. The outer anterior surface 16 is an essentially normal surface relative
20 to the proximal surface 12. Like the tapers of the lateral and medial surfaces, those of
21 the anterior and posterior surfaces were also chosen to mimic the tapers of the
22 appropriate portions of a human tibia. Once again, due to the relatively uniform
23 thickness, the tapers of the inner posterior and anterior surfaces (22 and 18,

1 respectively) will be the same as those of the corresponding outer posterior and
2 anterior surfaces (20 and 16, respectively).

3 The present invention also comprises a system of a plurality of
4 differently sized augments that can be held on hand in order to accommodate tibias of
5 different sizes. It is contemplated that three or four different sizes in the
6 anterior/posterior-medial/lateral direction should suffice for most applications. For
7 example, the lateral/medial dimension could range from about 40mm to about 80mm,
8 when measured from its widest point (which is at the proximal surface). Thus, if four
9 sizes were to be used, the lateral/medial dimension of the smallest tibial augment (at
10 its widest point) would be 48mm for an extra small augment, 52mm for a small
11 augment, 59mm for a medium augment and 67mm for a large augment. Additionally,
12 the anterior/posterior dimension could range from about 30mm to about 40mm, when
13 measured from the widest point in the anterior/posterior direction (which is at the
14 proximal surface). Thus, the approximate minimum dimensions for extra small, small,
15 medium, and large augments would be 33mm, 34mm, 36m and 38mm, respectively.

16 Further two different heights of augments should be available, where the
17 height is measured from the proximal surface 12 to the distal surface 14. In cases
18 where the decay has only extended a small distance into the tibia, a shorter augment
19 can be used than that needed where the decay has extended to a greater depth of the
20 bone. As a general rule, as much healthy bone should be preserved as possible.
21 However, if the decay is relatively deep, two augments of different sizes may be
22 stacked upon each other. For example, a small augment may be stacked upon an extra
23 small augment; a medium augment may be stacked upon a small augment; or a large

1 augment may be stacked upon a medium augment. Due to the shapes of the outer
2 peripheries of the augments, stacking essentially creates extensions of the outer lateral,
3 medial, posterior and anterior surfaces.

4 It is believed that two different heights should be sufficient to remedy
5 most tibial bone decay situations that are suitable for correction by implantation of a
6 tibial augment. For example, augments could be available in 15mm and 30mm
7 heights. However, more than two heights may also be produced, if desired. The tibial
8 augment 10 shown in Figures 1 through 3 is one example of an augment of the 30mm
9 height, and the tibial augment 40 shown in Figure 5 is one example of an augment of
10 the 15mm height. The augment 40 of Figure 5 is essentially the same as the augment
11 10 of Figures 1 through 4, except for the height thereof. Accordingly, the same index
12 numbers have been used in Figure 5 as those used in Figures 1 through 4.

13 In order to accommodate the requirements of most situations, multiple
14 sizes and shapes of augments may be desired. In the preferred embodiment of a set of
15 augments, six different sizes of augment are believed to be sufficient – extra small,
16 small, medium and large in a short height (such as 15mm) and medium and large in a
17 tall height (such as 30mm). Thus, in a system including these basic sizes, there is no
18 tall height (such as 30mm) augments in the extra small size or the small size. It is
19 believed that defective bone portions corresponding to these two sizes are better suited
20 to be corrected by other methods.

21 Of course, all of the dimensions discussed above (and below) are being
22 provided by way of example only, and other dimensions are also contemplated as
23 being within the scope of the invention. However, the dimensions provided, as

1 divided into four different increments, are believed to be able to accommodate the
2 needs of the majority of patients. Accordingly, only a limited stock of differently
3 sized augments would need to be kept on hand. Thus, for example, a kit of augments
4 would only need to contain four different sizes of augments of the 15mm height, and
5 two different sizes of augments of the 30mm height.

6 Turning now to Figures 6A through 6C, three different stepped versions
7 of a tibial augment are shown. More specifically, Figure 6A shows stepped augment
8 50, Figure 6B shows stepped augment 60 and Figure 6C shows stepped augment 70.
9 Since only the distal surface of the stepped augments is different from the augment of
10 Figures 1 through 4, only that portion needs to be discussed. In addition, the same
11 index numbers as those used in Figures 1 through 4 will be used for similar features
12 found in Figures 6A through 6C.

13 Figure 6A shows tibial augment 50, which includes a stepped distal
14 surface 14a/14b with a transition surface 52 therebetween. As shown in the figure,
15 distal surface 14a is located at a greater distance from the proximal surface 12 than
16 distal surface 14b. In this embodiment, the transition surface 52 is located
17 approximately midway between the outer medial surface 30 and the outer lateral
18 surface 26.

19 A second embodiment of a stepped tibial augment is shown in Figure
20 6B, as represented by tibial augment 60. In this embodiment, as in the Figure 6A
21 embodiment, distal surface 14a is located at a greater distance from the proximal
22 surface 12 than distal surface 14b. The main difference between this embodiment and
23 the Figure 6A embodiment is the location of the transition surface 52. In this

embodiment, the transition surface 52 is located closer to the outer lateral surface 26 than to the outer medial surface 30.

Figure 6C shows a third embodiment of a stepped tibial augment 70. In this embodiment, as in the embodiments of Figure 6A and 6B, distal surface 14a is located at a greater distance from the proximal surface 12 than distal surface 14b. The main difference between this embodiment and the other two embodiments is the location of the transition surface 52. In this embodiment, the transition surface 52 is located closer to the outer medial surface 30 than to the outer lateral surface 26.

The embodiments of Figures 6A through 6C are especially useful where there has been uneven tibial decay, i.e., where there is more decay on either the lateral side or the medial side than on the other side. By using one of the stepped tibial augments shown in Figures 6A through 6C, more healthy bone, if it exists on one side or the other, can be preserved, and mostly only defective bone will end up being removed when forming a stepped cavity to implant the tibial augment. In other words, the base of the cavity into which the stepped tibial augment will be implanted will be stepped to correspond to the stepped distal surface of the augment. Such a stepped-base cavity provides for preservation of more healthy bone on the shallower side, as compared with a flat-based cavity where bone has been removed to a depth equal to the depth of the lowest damaged area of bone.

Suggested heights for the stepped tibial augments of Figures 6A through 6C are 15mm and 30mm (as measured from the proximal surface 12 to the distal surfaces 14b and 14a, respectively). Of course, other heights are also contemplated as being within the scope of the invention.

Figure 7 shows an example of a human tibia 80 into which a cavity 82 has been prepared or formed in a proximal portion thereof. The cavity 82 of this example has a flat base 84, so it is suitable for tibial augments with flat distal surfaces, such as those depicted in Figures 1 through 5. However, those of ordinary skill in the art should be able to adapt the flat base 84 into a stepped base using the cavity forming techniques described hereinbelow.

The tibia 80 of Figure 7 is shown in a state prior to implantation of a tibial augment and a knee joint prosthesis. More specifically, the extreme proximal portion of the tibia 80 has been removed. Normally, most, if not all, of the removed proximal portion will be damaged tibial bone. However, a small amount of healthy bone may also need to be removed at the same time in order to provide a relatively flat surface upon which the flat-bottomed tibial base plate 102 (Figure 8) can be seated.

Either prior to removing the extreme proximal portion 86, or immediately after removing it (depending upon which surgical techniques are used), an intramedullary rod 88 may be inserted and used to define the relationship between the knee prosthesis stem and the tibial augment.

An example of a tibial augment 10 that has been implanted into a human tibia is shown in Figure 8. This figure shows how the tibial augment 10 that is seated within a cavity, such as cavity 82 of Figure 7, is positioned directly distal of the stemmed tibial base plate 102. Preferably, the tibial base plate 102 is cemented to the tibial augment 10. The remainder of the components of the knee joint prosthesis 100 (the articulating surface 106, the femoral component 108, etc.) are all implanted in the customary manner. It should be noted that although only one form of knee joint

1 prosthesis has been shown and described, the tibial augments of the present invention
2 can be used with other types of knee joint prostheses.

3 Figure 9 shows an example of a provisional tibial augment 90, which is a
4 temporary augment used as a test to ensure that the permanent augment will fit
5 properly within the cavity. Although only one size provisional is shown and
6 described, provisional augments should be made to correspond to every size of tibial
7 augment, including the stepped augments. There are two main differences between
8 the provisional augment 90 and the permanent augments of Figures 1 through 6C.

9 First, the provisional augment 90 may be made of a material which
10 indicates the bony areas of the provisional so that the surgeon can visualize how the
11 augment fits within the cavity. For example, the provisional may be made of a
12 transparent or photo-elastic material. One example of a suggested material for the
13 provisional is polyphenylsulfone, although other materials are also contemplated.

14 Second, provisional augments preferably include a set of grooves 92/94
15 on the inner medial surface 28 and the inner lateral surface 24. These grooves 92 and
16 94 extend in the generally lateral/medial direction, and are configured to cooperate
17 with ribs 96 on holder 110 shown in Figure 10. The holder 110 is designed to
18 facilitate insertion and removal of the provisional augment 90 to/from the cavity 82
19 (Figure 7) in order to determine that there is a proper fit between the cavity and the
20 provisional augment (and therefore there is necessarily a proper fit with the permanent
21 augment also, since both the provisional and the permanent augment are the same size
22 and shape).

1 The holder 110 includes two flexible legs 112 that extend in one
2 direction (to the left, as shown in Figures 10 and 11) to a body portion 114 that is
3 topped with a crown portion 116. As shown towards the right-hand sides of Figures
4 10 and 11, each leg 112 connects with a shoulder portion 118. Each shoulder portion
5 118 in turn extends into a finger portion 120, upon which the ribs 96 are situated. The
6 lowermost surfaces of the shoulders 118 each include a stop surface 122, which is
7 used to align the holder 110 with the proximal surface 12 of the provisional 90 (Figure
8 9) to facilitate the mating of the ribs 96 of the holder 110 with the grooves 92 and 94
9 of the provisional 90.

10 The holder 110 is preferably made of stainless steel, but it is
11 contemplated that it may also be fabricated from plastic. A key consideration when
12 selecting material is that the legs 112 must be flexible enough to be able to be biased
13 inwardly towards each other with light force applied from the surgeon's thumb and
14 forefinger, but they must also be resilient enough to return to their original positions
15 when the force is removed.

16 In use, the legs 112 of the holder 110 are flexed inwardly by the surgeon,
17 and the fingers 120 are inserted into the interior of the provisional 90 (which is an
18 annular member). Once the stops 122 contact the proximal surface 12 of the
19 provisional, the ribs 96 of the holder should be face to face with the grooves 92 and 94
20 of the provisional 90. Pressure on the legs 112 can now be released, and the legs 112
21 will flex outwardly until the ribs 96 mate with the grooves 92 and 94. At this point,
22 the holder 110 can be moved (such as by holding the crown portion 116 and/or by the

1 body portion 114), and the provisional 90 will remain attached to the holder 110, for
2 inserting/removing the provisional 90 to/from the cavity 82 (Figure 7).

3 One important feature of the holder 110 is that it can be disengaged from
4 the provisional without affecting the position of the provisional. Thus, once the
5 provisional is seated in the desired position, the legs 112 can be squeezed together, and
6 the holder 110 can be removed without disrupting the position of the provisional.

7 Only one size holder 110 has been shown, but it should be understood
8 that since the ribs of the holder are specifically configured to make contact with the
9 grooves on the inner surfaces of a provisional tibial augment, a different sized holder
10 is necessary for each different sized provisional. However, since the grooves are near
11 the proximal surface of the each provisional, no additional holder needs to be
12 fabricated for a provisional that has the same sized proximal surface as another
13 provisional. In the preferred set of augments and provisionals, there are six basic sizes
14 – (1) extra small with 15mm height; (2) small with 15mm height; (3) medium with
15 15mm height; (4) medium with 30mm height; and (5) large with 15mm height and
16 (6) large with 30 mm height. However, in the preferred embodiment, the 30mm height
17 medium-sized provisional (or augment) is essentially a 15mm height medium-sized
18 provisional (augment) stacked upon a 15mm height small-sized provisional (augment).
19 Similarly, in the preferred embodiment, the 30mm height large-sized provisional (or
20 augment) is essentially a 15mm large-sized provisional (augment) stacked upon a
21 15mm medium-sized provisional (augment). Thus, the 30mm height medium-sized
22 provisional can employ the same holder as the 15mm medium-sized provisional (since
23 they have the same proximal dimensions), and the 30mm large-sized provisional can

1 employ the same holder as the 15mm large-sized provisional. Accordingly, in the
2 preferred set of six differently sized provisionals, only four holders are utilized
3 because one holder does double duty for both the 30mm medium provisional and the
4 15mm medium provisional, and another holder does double duty for both the 30mm
5 large provisional and the 15mm large provisional.

6 Further, if extra small, small, medium and large stepped provisionals are
7 also included, the number of holders does not need to be increased because the rib
8 spacing on a stepped provisional is the same as that of a similarly sized flat-bottomed
9 provisional. Thus, the extra small holder can be used with the extra small stepped
10 provisional, the small holder with the small stepped provisional, the medium holder
11 with the medium stepped provisional, and the large holder with the large stepped
12 provisional.

13 Turning now to Figures 12 and 13, a second embodiment of the holder
14 will be shown and described. The second embodiment of the holder, which will be
15 designated as holder 111, is adjustable so that it can be used with provisionals of a
16 variety of different sizes, as well as with provisionals other than tibial augment
17 provisionals, such as femoral provisionals. Holder 111 includes a body portion 113
18 that serves as a handle and may optionally include a ribbed surface 115 that allows for
19 a more secure grip. The body portion 113, which defines a longitudinal axis (a vertical
20 axis as shown in Figures 12 and 13), is connected to a pair of legs 117. These legs 117
21 are each preferably L-shaped, and are preferably attached to the lower portion of the
22 body portion 113 by welding (although other attaching means, such as screws, may be
23 used instead). On the other hand, if desired, the legs 117 and the body portion 113

1 may be formed as a single unit, such as by casting, which will eliminate the need for
2 any attaching means for connecting the legs with the body portion. When viewed
3 together, the body portion 113 and the legs 117 define a generally fork-shaped
4 component, as shown in Figure 13.

5 Each of the legs 117 includes a finger 119 connected thereto. The
6 fingers 119 are preferably connected to the legs 117 via an externally threaded shaft
7 121. The threaded shaft 121 is divided in half such that one half is threaded in one
8 direction and the other half is threaded in the opposite direction. Each of the fingers
9 includes an internally threaded aperture 123 that is configured to mate with the
10 associated portion of the threaded shaft 121. Thus, when knob 125 is turned in one
11 direction, the threaded shaft 121 will rotate within threaded apertures 123, which will
12 cause the fingers 119 to separate from each other, and when the knob is turned in the
13 other direction, the fingers 119 will move towards each other. For example, the
14 threaded shaft 121 could be configured such that clockwise rotation of the knob 125
15 will cause the fingers 119 to move closer together and counterclockwise rotation will
16 cause the fingers to move farther apart (or, if desired, it could be configured in the
17 opposite manner, where clockwise rotation causes greater separation and
18 counterclockwise rotation reduces the separation distance). As shown in Figure 13,
19 each of the fingers 119 preferably includes a thickened portion 129, which serves to
20 increase the contact area between the threaded aperture 123 and the threaded shaft
21 121. Thickened portions 129 also provide stops that prevent the fingers 119 from
22 coming too close together.

1 For the purpose of connecting the threaded shaft 121 to the legs 117,
2 each of the legs preferably includes an open-ended slot 127 for receiving the ends of
3 the shaft, which are preferably not threaded. After one end of the threaded shaft 121
4 has been inserted into each slot 127, a small metal block is welded to each slot to close
5 its open-end, which serves to maintain the threaded shaft in position, while still
6 allowing rotation of the threaded shaft with respect to the legs. Of course, other
7 methods of attaching the threaded shaft 121 to the legs 117 are also contemplated as
8 being within the scope of the invention.

9 A secondary shaft 131 is also provided in parallel with the threaded shaft
10 121. The secondary shaft 131 is preferably not threaded, and is provided in order to
11 prevent the fingers 119 from rotating with respect to the legs 117 when the threaded
12 shaft 121 is rotated. The fingers 119 are connected to the secondary shaft 131 via a
13 pair of apertures 133 (where one aperture extends through each finger), which allows
14 the fingers to slide along, as well as rotate with respect to, the secondary shaft 131.
15 Optionally, in order to alleviate possible binding as the fingers 119 travel along the
16 secondary shaft 131, the secondary shaft may be slightly tapered from the center
17 thereof. For example, the center portion 135 may be made of full diameter, and
18 extending outwardly therefrom towards the legs 117, the secondary shaft 131 may
19 include a one degree taper (although tapers of different degrees may also be provided),
20 with the ends seated within apertures 133 preferably being of the same diameter as the
21 center portion 135. Preferably, the secondary shaft 131 is welded in place at the
22 apertures 133, although other ways of attaching the secondary shaft to the legs may
23 also be used. Additionally, other means of preventing the fingers 119 from rotating

1 with respect to the threaded shaft are also contemplated as being within the scope of
2 the invention. For example, the legs and/or the body portion may include some form
3 of protrusion extending therefrom for preventing rotation of the fingers 119 with
4 respect to the legs 117, but which still permits the fingers to move sideways (i.e.,
5 towards and away from each other) with respect to the legs. As another example, the
6 upper portions of the fingers 119 may be configured to include forks that extend
7 upwardly to straddle the legs 117 and/or the lower portion of the body portion 113.

8 Each of the fingers 119 also includes a rib 137, and they also each
9 preferably include a stop surface 139. As with holder 110 of Figures 10 and 11, the
10 ribs 137 of holder 111 are configured to mate with the grooves 92 and 94 of the
11 provisional 90 (Figure 9) for inserting and removing the provisional to/from the cavity,
12 and the stop surfaces 139 are used to align the holder 111 with the proximal surface 12
13 of the provisional 90 to facilitate mating the ribs of the holder with the grooves of the
14 provisional.

15 The holder 111 is preferably made of stainless steel or of another metal,
16 but other materials may be used for all or for only some of the components. For
17 example, plastic may be used for certain parts such as the body portion 113, the knob
18 125 and the secondary shaft 131, while a metal or other different material may be used
19 for the remaining components.

20 In order to accommodate many different sizes of tibial augment
21 provisionals, as well other types of provisionals (such as femoral provisionals), the
22 spacing of the fingers 119 should be able to be adjusted so that the fingers are far
23 enough apart to enable the ribs 137 to engage with the grooves of the largest

1 provisional, as well as to be adjusted to be close enough together for use with the
2 smallest provisional. For example, a distance of approximately two inches between
3 the outer surfaces of the fingers 119 when separated at the maximum distance and a
4 distance of approximately three quarters of an inch when separated at the minimum
5 distance should be sufficient for most uses. Of course, these dimensions are only
6 provided as a suggestion, and other dimensions may also be used.

7 In use, the knob 125 is rotated to separate the fingers 119 by a distance
8 that is less than the distance that separates the grooves of the provisional being acted
9 upon (such as grooves 92 and 94 of provisional 90 in Figure 9). The stop surface 139
10 is positioned upon the proximal surface of the provisional, and the ribs 137 of the
11 holder are aligned with the grooves 92 and 94 of the provisional 90 (Figure 9). The
12 knob 125 is again rotated to make the ribs 137 engage the grooves 92 and 92, and the
13 provisional 90 is inserted into the cavity 82 (Figure 7). The holder 111 can be
14 disengaged from the provisional 90 by rotating the knob 125 to bring the fingers 119
15 closer together, separating the ribs 137 from the grooves 92 and 94. One important
16 feature of the holder 111 is that it allows the ribs to be disengaged from the grooves
17 without significantly altering the location of the provisional within the cavity. When
18 the provisional 90 is to be removed from the cavity 82, the holder 111 is again used in
19 the manner described above.

20 The preferred embodiments of the provisional and holder combination
21 have been shown and described with grooves on the inner lateral and medial surfaces.
22 However, it is also contemplated that the grooves could be placed on the inner anterior
23 and posterior surfaces, and that the spacing of the fingers on the holder could be

1 adjusted accordingly. Further, detents could be substituted for the grooves, and a
2 spring loaded holder for mating with the detents could also be used.

3 It is also contemplated that other means for inserting the provisional may
4 also be used. For example, the provisional may include a threaded circular holder into
5 which a threaded handle member can be inserted and removed.

6 Turning now to Figures 14 through 17, these figures show an example of
7 a tibial augment pusher 130, which is used to seat a tibial augment within the cavity of
8 the proximal portion of the tibia. The pusher 130 (or one of the holders) may also be
9 used in conjunction with the provisional tibial augment as a tamp. In situations where
10 a bone graft is necessary to fill a void within the tibia in preparation for receiving the
11 provisional tibial augment within the cavity, the void could be filled with morselized
12 bone and the provisional tibial augment (in combination with a holder or pusher) could
13 be used to tamp the morselized bone into place.

14 The pusher 130 includes a handle portion 132 and an augment seating
15 portion 134. The augment seating portion 134 is further divided into a head portion
16 136 and a platform portion 138. The head portion 136 is preferably shaped to mimic
17 the interior surfaces of the tibial augment 10 (Figure 1), except the head portion 136 is
18 slightly smaller than the corresponding surfaces of the tibial augment 10 associated
19 therewith, which permits the head portion 136 to be easily seated within (and easily
20 withdrawn from) the tibial augment 10. More specifically, there is preferably
21 approximately 0.030 inches (0.762mm) clearance between the outer surface of the
22 head portion 136 and the inner surfaces of the tibial augment 10, as represented by
23 distance "X" in Figure 17, which includes (in the main view) a front view of pusher

1 130 and a magnified view of part of the head portion 136 of the same pusher, but with
2 a tibial augment 10 seated thereon. That is, the magnified view of Figure 17 shows the
3 head portion 136 in hidden lines to represent that the head portion is hidden behind the
4 augment 10, with the inner surface of the augment (also in hidden lines) spaced from
5 the outer surface of the head portion 136 by distance "X."

6 As also shown in the magnified portion of Figure 17, the proximal
7 surface 12 of the augment 10 contacts the planar surface 140 of the platform portion
8 138, which provides a surface from which the surgeon can apply light pressure to the
9 augment 10 to align, locate, and to seat it within the cavity 82 (Figure 7). As can be
10 seen in Figures 16 and 17, the planar surface 140 is provided upon the platform
11 portion 138 at the interface between the platform portion 138 and the head portion
12 136.

13 Since the shape of the head portion 136 mimics the shape of the interior
14 surfaces of the augment 10, it follows that the head portion 136 should have a taper of
15 approximately 19 degrees (+/- 3 degrees) at the surface that corresponds to the inner
16 medial and lateral surfaces (as shown in Figure 17), and that it should have a taper of
17 approximately 12 degrees (+/- 3 degrees) at the surface that corresponds to the inner
18 posterior surface (as shown in Figure 16). Further, as also shown in Figure 16, the
19 surface of the head portion 136 that corresponds to the inner anterior surface is not
20 tapered, but is instead substantially perpendicular to the platform portion 138.

21 In order to properly orient a tibial augment 10 within a cavity, the pusher
22 130 must have a head portion 136 that is appropriately shaped, as discussed above, and
23 the head portion must also be appropriately sized. Thus, as with the provisional

holders 110 discussed earlier, a number of pushers may be provided for the set of
augments. For example, if there are four sizes of augments (extra small, small,
medium and large), with two heights available (15mm and 30mm) for the medium
and the large sizes only, then there is a total of six differently sized augments.
Accordingly, as with the provisional holders 110, there should also be four differently
sized pushers -- one pusher for the 15mm extra small augment; one for the 15mm
small augment; one for the 15mm medium augment, the 30mm medium augment,
and the medium stepped augments; and one for the 15 large augment, the 30mm
large augment, and the large stepped augments.

In its preferred form, each pusher 130 is preferably made with an
aluminum handle portion 132 and an acetyl seating portion 134. However, other
materials can also be used. For example, the seating portion could be made from
various polymers or metals and the handle portion could be made of a different metal
or from plastic.

Turning now to Figures 18 through 28, a guide and several associated
osteotomes that are all used to create a cavity in the tibia are shown and will be
described next. One important aspect of the present invention is that the cavity formed
in the tibia (such as cavity 82 of Figure 7) must be carefully created so that the tibial
augment fits as precisely as possible. Among the advantages of a precise fit is that the
more precise the fit, the greater the stability of the implant. Accordingly, the present
invention includes tools and a method of creating a cavity of the proper size and shape.
Although only one method of creating the cavity will be shown and described, other
methods may also be used as a supplement to or in place of the method described. For

1 example, a rasp technique may be used to either create the cavity or to make fine
2 adjustments to a cavity created by another method. With such a technique, a rasp
3 shaped like a tibial augment (with a rasp-like outer surface and a handle) is used to
4 remove the bone and form the cavity (or to make fine adjustments to the shape of the
5 cavity).

6 Figure 18 shows a preferred embodiment of a guide 142 with a first
7 curved osteotome 144 inserted into a portion of a slot 146 formed within the guide
8 142. Figure 25 shows a second curved osteotome 148 (inserted into the guide 142),
9 and Figure 26 shows a straight osteotome 150 (also inserted into the guide 142). As
10 the following description will show, all three different osteotomes (144, 148 and 150)
11 are required to form the cavity 82 (Figure 7) because of the configuration of the slot
12 146, which is specifically configured to properly orient the osteotomes to create a
13 cavity that corresponds to the tibial augment being implanted therein. The osteotomes
14 144, 148 and 150 are preferably made of stainless steel, although other materials are
15 also contemplated.

16 As with several of the other components, the osteotomes and guides are
17 preferably configured in a variety of different sizes. In the preferred embodiment,
18 there are four sets of osteotomes (extra small, small, medium and large) and four
19 guides (extra small, small, medium, and large). As described more fully below, these
20 four sets of osteotomes and four guides can be used to create a cavity in the tibia for
21 any of the 15mm, 30mm or stepped augments of the preferred embodiment.

22 Turning first to Figures 18, 21 and 22, the first curved osteotome 144
23 includes a handle 152 with a crown 154 at the top end thereof. The curved osteotome

1 144 also includes a cutting portion 156 attached to the handle 152, and the cutting
2 portion includes a tapered edge 158 at its far end and a plurality of first (or distal)
3 stops 160 for hindering the cutting portion from extending into the slot 146 of the
4 guide 142 past a predetermined distance. The cutting portion 156 of the osteotome
5 144 also includes at least one second (or proximal) stop 162. As described more fully
6 below, the slot 146 in the guide 142 preferably includes a plurality of cutouts 147
7 (Figure 19), which allow the distal stops 160 to pass through in order to use the
8 proximal stop 162.

9 The proximal stop 162 is placed at a greater distance from the tapered
10 edge 158 than the distal stops 160, as can be seen in Figures 21 and 22. The use of
11 such staggered stops allows a single osteotome to be used to make two different
12 cavities of two different depths, depending upon which stop is used and also
13 depending upon which size guide is used. Thus, for example, assuming that tibial
14 augments are provided in two different heights (such as 15mm and 30mm),
15 accommodations must be made to provide cavities of two different depths (15mm and
16 30mm) so that the depth of the cavity coincides with the height of the tibial augment
17 being placed therein. When a shallow cavity is needed, the set of osteotomes is
18 inserted into the same sized guide (e.g., the set of small osteotomes is used with the
19 small guide, etc.) whereby the exterior stops 160 contact a planar top surface 143 of
20 the guide, hindering the cutting portion 156 from extending further into the guide, and
21 accordingly hindering further extension into the bone. By inserting the set of
22 osteotomes into the same sized guide, distal stops 160 do not mate with cutouts 147,
23 and therefore stops 160 do not pass through cutouts 147. On the other hand, if a deep

1 cavity is needed, the same set of osteotomes are inserted into the incrementally larger
2 guide (e.g. the small osteotomes are used with the medium guide), whereby the distal
3 stops 160 pass through cutouts 147 and the proximal stop 162 contacts the planar top
4 surface 143 of the guide, hindering the cutting portion 156 from extending further into
5 the guide, and accordingly hindering further extension into the bone. The distal and
6 proximal stops of the other osteotomes function in a similar manner. Although in the
7 examples provided the distal and proximal stops have been shown and described as
8 being on the radially exterior sides of the osteotomes, some or all of the stops may be
9 provided on the radially interior sides of the osteotomes. Of course, if all stops are
10 provided on the radially interior sides of the osteotomes, then the cutouts 147 on the
11 guide 142 would have to be changed to be on the radially interior side of the slot 146.
12 Additionally, if the distal stops are provided on the radially exterior side of the
13 osteotome and the proximal stops are provided on the radially interior side (or vice
14 versa), then the cutouts 17 could be omitted, if desired, as long as the slot was made
15 wide enough to accept the cutting portion 156 including the stops.

16 As mentioned above, Figure 25 shows an example of a second curved
17 osteotome 148. The second curved osteotome 148 is very similar to the first curved
18 osteotome 144 in that it also includes a handle 164, a crown 166, and a cutting portion
19 168 with a tapered edge 170 and a plurality of distal stops 172, as well as at least one
20 proximal stop 174.

21 Although it appears as though the first curved osteotome 144 and the
22 second curved osteotome 148 are identical to each other, but are just shown in
23 different orientations, in actuality, they are mirror images of each other. More

specifically, the front cutting area 176 of the first curved osteotome 144 and the front cutting area 178 of the second curved osteotome 148 each have no inclination, which corresponds to the outer anterior surface 16 of the tibial augment 10 (Figure 4) that also has no incline. Similarly, since the outer posterior surface 20 preferably has an incline of approximately 12 degrees (although inclines within the range of between about 0 to about 17 degrees may also be used), as shown in Figure 4, the posterior cutting area 184 of the first curved osteotome 144 and the posterior cutting area 186 of the second curved osteotome 148 is also provided with an incline of 12 degrees (or a corresponding incline within the range of about 0 to about 17 degrees, depending upon the exact degree of incline provided to the anterior surface of the tibial augment). Likewise, the outer medial surface 30 and the outer lateral surface 26 of the tibial augment 10 are preferably inclined at 19 degrees (or within the range of between about 8 to about 30 degrees), as shown in Figure 3, the side cutting area 180 of first curved osteotome 144 and the side cutting area 182 of second curved osteotome 148 are also inclined at 19 degrees (or at whatever selected angle between 8 and 30 degrees that the outer lateral and outer medial surfaces of the augment are provided at). Figures 23 and 24 also show how cutting portion 156 is a mirror image of cutting portion 168. Accordingly, the second curved osteotome 148 is not interchangeable with the first curved osteotome 144.

Figures 26 through 28 show straight osteotome 150. Like the other osteotomes, the straight osteotome includes a handle 188, a crown 190, and a cutting portion 192 with a tapered edge 194, distal stops 196, and at least one proximal stop 198. As shown in Figure 27, the cutting portion 192 is preferably inclined with

1 respect to the handle. This degree of incline corresponds to the degree of incline of
2 the outer posterior surface 20 of the tibial augment 10 (Figure 4). Thus, in the
3 preferred embodiment, there is an incline of approximately 12 degrees. However,
4 inclines of between approximately 0 degrees and approximately 17 degrees are also
5 contemplated as being within the scope of the invention, as well as other degrees of
6 incline. The orientation of the cutting portion 192 with respect to the handle 188 of
7 this osteotome, as well as the other osteotomes, is intended to allow for the proper
8 cutting angle when the handle is held perpendicular to the tibial surface within which
9 the cavity 82 (Figure 7) has been formed.

10 Moreover, as shown in Figures 18 through 20, 25 and 26, the guide 142
11 is also provided so that the proper cutting orientation of the osteotomes is maintained,
12 which thereby aids in making a cavity with sidewalls of inclines that correspond to the
13 inclines on the outer surfaces of the tibial augment. As mentioned earlier, the guide
14 142 includes a slot 146 for guiding the cutting portions (156, 168, 192) of the
15 osteotomes (144, 148, 150). Each portion of the slot 146 is made with a particular
16 incline that matches the incline of the corresponding outer surface of the tibial
17 augment associated therewith. Thus, for example, as shown in hidden lines in Figure
18 18, the slot's lateral portion 200 and the slot's medial portion 202 are inclined,
19 respectively, to match the slopes of the outer lateral surface 26 and the outer medial
20 surface 30 of the tibial augment 10, which in the preferred embodiment is a 19 degree
21 incline. Likewise, the slot's posterior portion 204 and its anterior portion 206 are also
22 configured to correspond of the incline of, respectively, the outer posterior surface 20
23 and the outer anterior surface 16 of the tibial augment 10. Thus, in the preferred

embodiment, the slot's posterior portion 204 will be inclined at approximately 12 degrees and the slot's anterior portion 206 will have no incline.

The guide 142 also includes a securing arrangement that is used to secure the guide to the bone within which the cavity is being formed. The securing arrangement includes an aperture 208 that is configured to receive the intramedullary rod 88 (Figure 7), which serves as both a reference point for the guide and as the stable member that the guide is secured upon. The securing arrangement also includes a threaded hole 210 (Figure 18) that is configured to receive a setscrew 212 (Figure 19), which is comprised of a head 214 and a threaded shaft 216. Alternately, the setscrew could also be replaced with a thumbscrew or the head could be replaced with a lever or small handle to facilitate tightening without the need for a screwdriver. The threaded hole 210 is preferably made within a collar 218, which allows for additional length of the setscrew 212, and also allows for also easier access to the head of the setscrew, which may be necessary, especially if a thumbscrew or other similar component is used in place of the setscrew.

The slot 146 of the guide 142 is not annular, but instead includes a gap near its anterior portion 206, as best shown in Figure 19. This gap is where the threaded shaft 216 of the setscrew extends through the guide. If this gap in the slot 146 were not present, there is a chance that the threaded shaft 216 of the setscrew could accidentally be damaged if an osteotome were inserted into the slot at this area. Damaging the setscrew could result in misalignment of the guide with respect to the bone, or it could make it difficult to remove the guide from the intramedullary rod 88.

With regard to sizing, there should be one guide and one set of three osteotomes (two curved and one straight osteotome) for each 15mm sized tibial augment. Further, additional guides and osteotomes need not be provided for the 30mm sized or for the stepped augments. Thus, if four sizes of augments (extra small, small, medium and large) are provided, there should be four different sizes of guides and four sets of osteotomes, with three osteotomes in each set, for a total of twelve different osteotomes. To make cavities for any of the 15mm augments, the same sized set of osteotomes and guide are used. For example, to make a cavity for a 15mm extra small augment, the extra small set of osteotomes and the extra small guide is used. However, to make a cavity for one of the 30mm augments, the same sized guide is used, but the set of osteotomes for the next smaller size is used. For example, to make a cavity for a 30mm medium augment, the medium guide is used along with the small set of osteotomes. In other words, no matter what depth cavity is being created (15mm or 30mm), the guide that is the same size as the augment being inserted (extra small, small, medium or large) will always be used. However, when 30mm depth cavities are being created, the set of osteotomes of one size smaller than the augment are used, otherwise (for 15mm depth cavities), the set of osteotomes of the same size as the augment are used.

To further clarify this point, the following specific examples are provided. Assume that one intends to prepare a cavity suitable for the medium sized augment (of either 15mm height or 30mm height). First, for either case (15mm or 30mm), the medium sized guide 142 is affixed to the intramedullary rod 88. For creating a 15mm depth cavity for the medium augment, medium osteotome 144 is

1 inserted into the correspondingly sized medium guide, whereby the distal stop 160
2 contacts the planar top surface 143 of the guide, hindering the cutting portion 156
3 from extending further into the guide, past the desired 15mm depth. The other
4 medium osteotomes are also used in the same manner, with the stops operating in a
5 similar manner to create a 15mm depth cavity for the 15mm medium augment.

6 To create a 30 mm depth cavity for the 30mm medium augment, the set
7 of small osteotomes (i.e., the osteotomes of one incremental size smaller than the
8 augment) would be inserted into the appropriate position of the slot 146, instead of
9 using the medium osteotomes discussed above. When small osteotome 144 is
10 appropriately inserted into the incrementally larger medium guide, the distal stop 160
11 passes through the medium guide cutout 147, allowing the cutting portion 156 of the
12 osteotome to extend further into the bone until the proximal stop 162 contacts the
13 planar top surface 143 of the guide. The contact of the proximal stop 162 with the top
14 planar surface hinders the cutting portion from extending further into the guide than
15 the desired 30mm, and accordingly hinders further extension into the bone. (On the
16 other hand, if small osteotome 144 is inserted into the correspondingly sized small
17 guide, the distal stop 160 contacts the planar top surface 143 of the guide, hindering
18 the cutting portion of the 156 from extending further into the guide so that a 15mm
19 deep cavity can be created). The distal and proximal stops of the other small
20 osteotomes function in a similar manner, and a 30mm depth cavity for the medium
21 augment is created by using all three small osteotomes with the medium guide.

22 To form a cavity in the proximal portion of the tibia, an appropriately
23 sized guide 142 and an appropriately sized set of osteotomes are selected. After the

1 intramedullary rod 88 (Figure 7) has been implanted within the tibia 80, the aperture
2 208 of the guide 142 is slid over the intramedullary rod 88, and the guide 142 is
3 secured in place by tightening the setscrew 212. It should be noted that the aperture
4 208 is preferably triangular, as best shown in Figure 19, which allows for the
5 intramedullary rod 88 to have an increasingly secure fit as the setscrew is tightened
6 because of the way the rod is seated at the apex of the triangle.

7 Once the guide 142 is securely attached to intramedullary rod 88, one of
8 the appropriately sized osteotomes, such as the first curved osteotome 144, is inserted
9 into the appropriate position of the slot 146. More specifically, the first curved
10 osteotome 144 is inserted into portion 200 of the slot 146. It should be noted that the
11 osteotomes may be used in any desired order.

12 As discussed above, the desired depth of cavity is formed by using the
13 appropriate combination of a particularly sized set of osteotomes with an appropriately
14 sized guide, whereby either proximal stops 198 or distal stops 196 are utilized to result
15 in a cut of an appropriate depth. Also, if one of the stepped tibial augments shown in
16 Figures 6A through 6C is intended to be implanted, cuts of one depth may be made at
17 one area of the cavity and cuts of another depth may be made at another area in order
18 to form an appropriate cavity with a stepped bottom to accommodate the stepped distal
19 surface 14a/14b of Figures 6A through 6C.

20 Next, one of the other osteotomes, such as the straight osteotome 150
21 (Figures 26-28), is inserted into the appropriate portion of the slot. As shown in
22 Figure 26, the straight osteotome 150 is inserted into the slot's posterior portion 204
23 (best seen in Figure 19). As described above, the appropriate stop, or stops, (either

1 proximal stop 198 or distal stops 196) is/are utilized to result in a cut of the
2 appropriate depth.

3 Finally, the remaining osteotome, which in this case is the second curved
4 osteotome 148 (Figure 25), is inserted into the appropriate portion of the slot 146,
5 which in this case is the medial portion 202 (Figure 19). As with the other osteotomes,
6 the appropriate stop, or stops, (either proximal stop 174 or distal stops 172) is/are
7 utilized to result in a cut of the appropriate depth. After all three osteotomes have
8 been used, the guide 142 may be removed from the intramedullary rod 80 by loosening
9 the setscrew 218 and sliding the guide upwardly and off of the intramedullary rod. At
10 this point, the bone to be removed should be cut to the desired depth, and it merely
11 needs to be taken from the site to form the cavity 82 (Figure 7). If necessary, an
12 additional cut may need to be made with the straight osteotome 150, or one of the
13 other osteotomes, at the area below the gap in the slot 146, between the two edges of
14 the anterior portion 206 (Figure 19). However, the decayed bone at that area may
15 simply fall from the peripheral bone without requiring an additional cut. Once the
16 bone is completely removed from within the cut area formed by the osteotomes, a
17 cavity that corresponds to the tibial augment being inserted therein should result.

18 After forming the cavity, which alternatively could be formed using the
19 rasp technique mentioned earlier, as well as by other known techniques, the
20 provisional augment 90 (Figure 9) may be temporarily implanted to determine whether
21 the cavity is properly sized, or if additional bone needs to be removed. The
22 provisional may be inserted either with the aid of one of the holders 110 or 111
23 (Figures 10 and 12) or by using one of the pushers 130 (Figure 14), or with a

1 combination of both a holder and a pusher. At this point, the provisional 90 may also
2 be used to trial the locations of the tibial base plate provisionals (or the provisionals of
3 the tibial tray and stem). After the fit is adequately tested with the provisional 90, it
4 can be removed by using the provisional holder 110 or 111 in the manner previously
5 described. Then, the permanent tibial augment, such as augment 10 of Figure 1, is
6 inserted using the pusher 130 (Figure 12). After properly seating the augment within
7 the cavity, cement is applied to the proximal surface 12 of the augment, and the
8 stemmed tibial base plate 102 (Figure 8) is attached to the augment and to the
9 peripheral bone remaining around the cavity. Then, the remainder of the knee joint
10 prosthesis 100 is attached using any desired method, and the surgical procedure
11 continues in the customary manner.

12 While various embodiments of the present invention have been shown
13 and described, it should be understood that other modifications, substitutions and
14 alternatives may be apparent to one of ordinary skill in the art. Such modifications,
15 substitutions and alternatives can be made without departing from the spirit and scope
16 of the invention, which should be determined from the appended claims.

17 Various features of the invention are set forth in the appended claims.